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(12) # EUROPEAN PATENT SPECIFICATION

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(54) **Motor controller having SCR's.**

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US-A- 3 436 645
US-A- 4 468 726

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Description

Background of the Invention

The present invention relates to systems for controlling the operation of an electric motor, and more particularly to such systems in which unidirectional electric switches are employed to control the application of electricity to the motor.

The operation of three-phase electric motors is frequently controlled by an apparatus which regulates the flow of electricity to the motor in order to reduce power consumption during the starting of the motor and control the motor speed during normal running conditions. Such apparatus commonly uses thyristors to switch each phase of electricity to the motor. A typical configuration consists of two silicon controlled rectifiers (SCR) connected in an inverse parallel relationship for each phase of the electricity. An electronic control circuit senses the polarity of the alternating voltage for each phase and triggers the corresponding SCR's which are forward biased during each half cycle of the voltage. The control circuit also regulates the phase angle of the voltage cycle at which each SCR is triggered to control the magnitude of electricity applied to the motor and thereby control the power consumption and speed. For example, during the start up of the motor, the phase angle at which each SCR is triggered is gradually decreased so as to slowly increase the amount of electricity applied to the motor.

An alternative control system replaced one of the SCR's in each inverse parallel connected pair with a diode. The diode/SCR combination improves the stability of the motor. control during starting. In this case, the connection of this phase of the electricity source to the motor was conductive for the entire half cycle of the voltage during which the diode was forward biased. This alternative eliminated the need to provide a trigger signal during this half cycle of the voltage for that phase. The problem with this circuit is that each diode remains conducting even when the motor is turned off by the control circuit. Although the SCR's in the control circuit are turned off, current still can flow through the diodes and leak to the motor housing which is typically grounded. This leakage current deteriorates the insulation and components within the motor.

Previous controllers overcame this problem by utilizing two inverse parallel connected SCR's in each phase and triggering one of the SCR's during the entire half cycle of the supply voltage during which the SCR was forward biased. As a result of this triggering, one of the SCR's acted as a diode. Although this operation solved the problem of current leakage when the motor was turned off, it still required a complex control circuit to apply a second trigger pulse for each phase of the motor supply voltage and consumed additional power for the triggering.

An apparatus in accordance with the preambles of claims 1 and 6 is known from US-A-3 436 645. This known apparatus is directed to a polyphase system. A switching device consisting of an uncontrolled unidirectional electrical switch (diode) and a controlled unidirectional electrical switch (SCR or thyristor) connected in inverse parallel relationship to the uncontrolled unidirectional electrical switch is provided in each phase of the polyphase system. When a motor start switch is closed the switching devices are abruptly rendered bidirectionally conductive by applying a control signal from a control circuit to the controlled unidirectional electrical switches. When a motor stop switch is closed the application of the control signal is interrupted and as a result thereof the controlled unidirectional electrical switches return to a nonconducting state.

US-A-4 468 726 discloses a converter having optically triggered thyristors.

Summary of the Invention

The invention as recited in claim 1 or 6 solves the problem to control the application of electricity to an electric motor not only in a stable but also economical and simple manner.

More specifically, in accordance with the invention an apparatus for controlling an electric motor includes first and second unidirectional electrical switches connected in an inverse parallel relationship coupling the motor to a source of electricity. The first unidirectional electric switch is electrically activated by a signal from a control circuit which regulates the times at which that switch is turned on. A power supply is provided to furnish electricity to the control circuit. The power supply includes a voltage rectifier and a light emitter connected in series. The emitter is optically coupled to the second unidirectional electric switch so that light from the emitter will activate that switch. The light emitter and its associated SCR are connected into the control circuit so that light triggers the SCR when it is forward biased.

In an enhanced version of the present invention, a means is provided to inhibit the emitter from producing light when the motor is turned off. This inhibitor can be a transistor connected in parallel with the light emitter to create a switchable shunt path for the electricity to bypass the emitter when the motor is turned off. When the transistor is rendered conductive thereby closing the shunt path, electricity still is furnished by the power supply to the control circuitry.

A general object of the present invention is to provide a stable system for controlling the application of electricity to an electric motor in which each phase of that electricity is controlled by two inverse parallel connected unidirectional electric switches.

Another object of the present invention is to provide a means for economically and simply operating one of the electric switches to function as a diode.

Yet another object of the present invention is to activate one of the unidirectional electric switches optically utilizing light generated by the current flowing through the power supply for the system. This technique reduces the power consumption as the existing power supply current activates the switches.

A further object of the present invention is to incorporate a mechanism for deactivating the diode-operating unidirectional electric switch when the motor is turned off.

Brief Description of the Drawing

Fig. 1 is a block schematic diagram of a motor controller incorporating the present invention.

Fig. 2 is a block schematic diagram of another embodiment of the present invention.

Detailed Description of the Invention

With reference to Fig. 1, a motor control circuit, generally designated as 10, couples an AC electric motor 12 to three phases, A, B, and C, of a source of alternating electricity. The three phases of electricity are applied to input terminals 13, 14, and 15 and the motor 12 is connected to three output terminals 16, 17, and 18 of the control system 10. A first silicon-controlled rectifier (SCR) 21 connects the first input terminal 13 to the first output terminal 16. Similarly, second and third SCR's 22 and 23 couple the second and third input terminals 14 and 15 to the second and third output terminals 17 and 18, respectively. A first optically triggered SCR 24 is connected in an inverse parallel relationship with the first SCR 21. Similarly, second and third optically triggered SCR's (opto-SCR's) 25 and 26 are connected in inverse parallel relationships with the second and third SCR's 22 and 23, respectively.

The system 10 contains a conventional control circuit 20 which in response to the voltages at each of the three input terminals 13, 14, and 15 produces signals for triggering the three SCR's 21-23. The operation of the control circuit is governed by signals on a set of input lines 19 which indicate when to start and stop the motor and its speed. These signals can originate at a manual control panel, for example. The control circuit 20 can be any of several standard devices that regulate the phase angle of the input voltage for the motor at which each of the respective SCR's is triggered. This controlling of the phase angle triggering controls the amount of electricity applied to the motor and provides a slow start and speed regulation for the motor using well known techniques.

The system 10 also includes a power supply 30 which furnishes a DC voltage to the control circuit 20. The power supply 30 is coupled to the three input terminals 13-15 by three resistors 28 which drop the three phase voltages to levels compatible with the supply requirements of the control circuit 20. The three resistors 28 supply electricity to a three-phase rectifier bridge having six diodes 31-36, each forming a leg of the rectifier bridge. Specifically, diodes 31, 32, and 33 couple each of the resistors 28 to a positive output terminal 37 for the power supply. The remaining diodes 34, 35, and 36 of the rectifier bridge are each connected in series with a separate light emitting diode (LED) 41, 42, and 43, respectively. Each series combination of a diode and an LED couples one of the resistors 28 to a ground terminal 38 of the power supply. The diodes are connected so that the voltage potential at terminal 37 will be positive with respect to the ground terminal 38.

The first LED 41 is optically coupled to the first opto-SCR 24, as indicated by dashed line 44, so that the light emitted by the LED will trigger the SCR. Although LED 41 and opto-SCR 24 are shown as separate devices, they typically are mounted in a common package to provide the optical coupling. Similarly, the second LED 42 is optically coupled to the second opto-SCR 25 and the third LED 43 is optically coupled to the third opto-SCR 26, as indicated by dashed lines 45 and 46 respectively. The LED's are placed in the proper legs of the rectifier bridge so that they will be forward biased and emit light when their associated opto-SCR is also forward biased.

A zener diode 48 and a filter capacitor 49 are connected in parallel between the positive terminal 37 and the ground terminal 38 of the power supply 30. These terminals 37 and 38 are also connected to the power input terminals of the control circuit 20 to furnish a DC voltage for powering the control circuit.

The power supply 30 further includes a separate, identical turn-off circuit 50, 51, and 52 coupled in parallel with each of the LED's 41, 42, and 43. The details of the turn off circuits are shown for the first one 50. The first turn off circuit 50 includes a shunt transistor 56 coupled across the first LED 41 and two biasing resistors 57 and 58. The base of the shunt transistor 56 is coupled to an output line 60 from the control circuit 20 which controls the operation of the turn-off circuit 50, as will be described. Each of the other turn-off circuits 51 and

52 also are coupled to the control circuit output line 60.

When the control circuit 20 receives an input command via input lines 19 indicating that the motor 12 is to be turned on, it applies trigger pulses to each of the SCR's 21, 22, and 23 during the positive half cycle of the corresponding AC phase A, B, or C to which the SCR's are connected. The trigger signals are applied at different phase angles with respect to the AC voltage cycle in order to regulate the amount of current applied to the motor in a conventional manner.

At the same time a positive control voltage is applied via line 60 to turn off the shunt transistors 56 in the turn off circuits 50-52. Therefore, during the negative half cycle of the voltage at each of the input terminals A, B, and C, light is emitted from the LED 41, 42, or 43 which is connected to that phase line. This light activates the optically coupled opto-SCR 24, 25, or 26 during the negative half cycle of each phase. For example, during the negative half cycle of the voltage for phase A at the first input terminal 13, current will flow within the power supply 30 from the ground terminal 38 through the first LED 41, diode 34, and one of the resistors 28 to the first input terminal 13. This flow of electricity will produce light from the first LED 41 which is coupled to the first opto-SCR 24 rendering that SCR conductive. As a result, during the negative half cycles of the voltage appearing at the input terminal 13, the first opto-SCR 24 will be conductive allowing current to flow from the first output terminal 16 to the first input terminal 13. The remaining LED's 42 and 43 similarly emit light to turn on their associated opto-SCR 25 and 26 during the negative half cycles of the respective phase voltages at terminals 14 and 15.

This activation of the opto-SCR's 24, 25, and 26 causes them to act as diodes without the need for trigger pulses from control circuit 20 whenever the motor is turned on. Since the current for triggering the opto-SCR's comes from the rectifier bridge of the system power supply 30, very little additional power is expended in this triggering as compared to using trigger signals from control circuit 20.

When the control circuit 20 receives a command via input lines 19 to turn off the motor 12, it ceases triggering SCR's 21, 22, and 23. At this time, the control circuit also emits a negative voltage on control line 60 which is coupled to each of the turn-off circuits 50-52. This negative control voltage turns on the shunt transistors 56 in each of the turn-off circuits. When the shunt transistors 56 are conductive, current will flow through them bypassing the LED connected in parallel with the transistor.

When the motor is turned off, current still flows through each leg of the rectifier bridge in the power supply 30 to furnish power to the control circuit 20. However, with the transistors 56 in each of the turn-off circuits 50-52 rendered conductive at this time, the current does not flow through LED's 41-43. Since the current is not flowing through the LED's 41-43, they will not emit light and the opto-SCR's 24, 25, and 26 will not be turned on. As a consequence, the opto-SCR's do not function as diodes when the motor is turned off, eliminating the possibility of current leakage through the motor and the adverse effects previously discussed.

As an alternative to using opto SCR's 24, 25 and 26, conventional electrically triggered SCR's 71, 72 and 73 may be used as shown in Fig. 2. In this embodiment, the LED's 41, 42 and 43 in the power supply 30 have been replaced by standard opto-isolator devices 61, 62 and 63 to optically activate said SCR's 71, 72 and 73. The opto-isolator device responds to current flowing between node 38 and the associated diode 34, 35 or 36 by issuing a trigger signal on output line 64, 65 or 66. The output lines 64, 65 and 66 are connected to control terminals 67, 68 and 69, respectively, on SCR's 71, 72 and 73. The operation of the controller in Fig. 2 is equivalent to that of the controller in Fig. 1. Specifically, the first set of SCR's 21, 22 and 23 is triggered by control circuit 20 and the second set of SCR's 71, 72 and 73 is triggered by current flowing through the power supply 30.

Claims

1. An apparatus for controlling an electric motor comprising:

a first unidirectional electrical switch (21, 22, 23) coupling the motor (12) to a source (A, B, C) of electricity and being activated by an electrical signal to regulate the times at which that switch is turned on,

a second unidirectional electrical switch (24, 25, 26) connected in inverse parallel relationship to said first unidirectional electrical switch,

a control circuit (20) for electrically activating the first unidirectional electrical switch, characterized by

said second unidirectional electrical switch (24, 25, 26) being optically activated,

a power supply (30) for furnishing an electric current to said control circuit, and

a light emitter (41, 42, 43) energized by electric current flowing through said power supply to said control circuit to produce light which is optically coupled to activate said second unidirectional electrical switch.

2. The apparatus as recited in claim 1, wherein said powder supply (30) includes means (31, 32, 33, 34, 35, 36) coupled in series with said light emitter, for rectifying the electric current to said control circuit.

3. The apparatus as recited in claim 1 or 2, further comprising means (50, 51, 52) for preventing the light emitter from emitting light when the motor is turned off.

4. The apparatus as recited in claim 3, wherein the means for preventing comprises a switch element (56) providing a shunt path for current to bypass the light emitter when the motor is turned off.

5. The apparatus as recited in claim 4 wherein said switch element (56) is controlled by said control circuit (20).

6. An apparatus for controlling a three-phase alternating current electric motor comprising:

first, second, and third input terminals (13, 14, 15) for connecting the apparatus to three phases of alternating current,

first, second and third output terminals (16, 17, 18) for connecting the apparatus to the motor (12),

first, second and third unidirectional electrical switches (21, 22, 23) each being activated by an electrical signal to regulate the times at which each switch is turned on wherein said first unidirectional electrical switch (21) couples the first input terminal (13) to the first output terminal (16), said second unidirectional electrical switch (22) couples the second input terminal (14) to the second output terminal (17), and said third unidirectional electrical switch (23) couples the third input terminal (15) to the third output terminal (18),

fourth, fifth and sixth unidirectional electrical switches (24, 25, 26) wherein said fourth unidirectional electrical switch (24) is connected in inverse parallel relationship to said first unidirectional electrical switch (21), said fifth unidirectional electrical switch (25) is connected in inverse parallel relationship to said second unidirectional electrical switch (22), and said sixth unidirectional electrical switch (26) is connected in inverse parallel relationship to said third unidirectional electrical switch (23), and

a control circuit (20) for electrically activating the first, second, and third unidirectional electrical switches, characterized by

said fourth, fifth and sixth unidirectional electrical switches (24, 25, 26) each being optically activated,

a power supply (30) for furnishing an electric current to said control circuit including three rectifiers (31, 32, 33) coupling said input terminals (13, 14, 15) to a first power supply terminal (37), and further including three sets of a light emitter (41, 42, 43) and a rectifier (34, 35, 36) with each set being electrically coupled between a different one of said supply terminals (13, 14, 15) and a second power supply terminal (38) and each light emitter optically coupled so that light therefrom activates a different one of said fourth, fifth and sixth unidirectional electrical switches (24, 25, 26).

7. The apparatus as recited in claim 6 further comprising means (50, 51, 52) for preventing the light emitters from emitting light when the motor is turned off.

8. The apparatus as recited in claim 7 wherein said means for preventing includes a separate switchable shunt circuit (56) connected in parallel with each of the light emitters and rendered conductive when the motor is turned off.

9. The apparatus as recited in claim 8 wherein said switchable shunt circuit is operated by said control circuit (20).

Patentansprüche

1. Vorrichtung zum Beeinflussen eines Elektromotors, enthaltend:

einen ersten unidirektionalen elektrischen Schalter (21, 22, 23), über den der Motor (12) mit einer Elektrizitätsquelle (A, B, C) verbunden ist und der von einem elektrischen Signal aktiviert wird, um die Zeiten, zu denen der Schalter eingeschaltet wird, einzustellen,

einen zweiten unidirektionalen elektrischen Schalter (24, 25, 26), der zu dem ersten unidirektionalen elektrischen Schalter antiparallelgeschaltet ist,

eine Ansteuerschaltung (20) zum elektrischen Aktivieren des ersten unidirektionalen elektrischen Schalters,

gekennzeichnet durch

optische Aktivierung des zweiten unidirektionalen elektrischen Schalters (24, 25, 26),

eine Energieversorgung (30) zur Lieferung eines elektrischen Stroms an die Ansteuerschaltung, und

einen Lichtemitter (41, 42, 43), der von dem durch die Energieversorgung zur Ansteuerschaltung fließenden elektrischen Strom erregt wird, um Licht zu erzeugen, das zum

Aktivieren des zweiten unidirektionalen elektrischen Schalters optisch gekoppelt wird.

2. Vorrichtung nach Anspruch 1, bei der die Energieversorgung (30) eine Einrichtung (31, 32, 33, 34, 35, 36) enthält, die mit dem Lichtemitter in Reihe geschaltet ist und zum Gleichrichten des elektrischen Stroms zur Ansteuerschaltung dient.

3. Vorrichtung nach Anspruch 1 oder 2, ferner enthaltend eine Einrichtung (50, 51, 52), die, wenn der Motor ausgeschaltet wird, den Lichtemitter an der Emission von Licht hindert.

4. Vorrichtung nach Anspruch 3, bei der die Hinderungseinrichtung ein Schaltelement (56) enthält, das, wenn der Motor ausgeschaltet wird, einen Nebenschlußweg für den Strom zum Umgehen des Lichtemitters vorsieht.

5. Vorrichtung nach Anspruch 4, bei der das Schaltelement (56) von der Ansteuerschaltung (20) angesteuert wird.

6. Vorrichtung zum Beeinflussen eines Dreiphasenwechselstrom-Elektromotors, enthaltend:

einen ersten, zweiten und dritten Eingangsanschluß (13, 14, 15) zum Verbinden der Vorrichtung mit den drei Wechselstromphasen,

einen ersten, zweiten und dritten Ausgangsanschluß (16, 17, 18) zum Verbinden der Vorrichtung mit dem Motor (12),

einen ersten, zweiten und dritten unidirektionalen elektrischen Schalter (21, 22, 23), von denen jeder durch ein elektrisches Signal zum Einstellen der Zeiten, zu denen jeder Schalter eingeschaltet wird, aktiviert wird, wobei der erste unidirektionale elektrische Schalter (21) den ersten Eingangsanschluß (13) mit dem ersten Ausgangsanschluß (16), der zweite unidirektionale elektrische Schalter (22) den zweiten Eingangsanschluß (14) mit dem zweiten Ausgangsanschluß (17) und der dritte unidirektionale elektrische Schalter (23) den dritten Eingangsanschluß (15) mit dem dritten Ausgangsanschluß (18) verbindet,

einen vierten, fünften und sechsten unidirektionalen elektrischen Schalter (24, 25, 26), wobei der vierte unidirektionale elektrische Schalter (24) zu dem ersten unidirektionalen elektrischen Schalter (21) antiparallelgeschaltet ist, der fünfte unidirektionale elektrische Schalter (25) zu dem zweiten unidirektionalen elektrischen Schalter (22) antiparallelgeschaltet ist und der sechste unidirektionale elektrische Schalter (26) zu dem dritten unidirektionalen elektrischen Schalter (23) antiparallelgeschaltet ist, und

eine Ansteuerschaltung (20) zum elektrischen Aktivieren des ersten, zweiten und dritten unidirektionalen elektrischen Schalters,

gekennzeichnet durch

optische Aktivierung des vierten, fünften und sechsten unidirektionalen elektrischen Schalters (24, 25, 26),

eine Energieversorgung (30) zum Liefern eines elektrischen Stroms zu der Ansteuerschaltung enthaltend drei Gleichrichter (31, 32, 33), die die Eingangsanschlüsse (13, 14, 15) mit einem ersten Energieversorgungsanschluß (37) verbinden, und ferner enthaltend drei Gruppen jeweils bestehend aus einem Lichtemitter (41, 42, 43) und einem Gleichrichter (34, 35, 36), wobei jede dieser Gruppen jeweils zwischen einen anderen der Eingangsanschlüsse (13, 14, 15) und einen zweiten Energieversorgungsanschluß (38) geschaltet ist und jeder Lichtemitter optisch derart gekoppelt ist, daß das jeweilige Licht davon einen anderen der vierten, fünften und sechsten unidirektionalen elektrischen Schalter (24, 25, 26) aktiviert.

7. Vorrichtung nach Anspruch 6, ferner enthaltend eine Einrichtung (50, 51, 52), die, wenn der Motor abgeschaltet wird, die Lichtemitter an der Emission von Licht hindert.

8. Vorrichtung nach Anspruch 7, bei der die Hinderungseinrichtung eine separate schaltbare Nebenschlußschaltung (56) enthält, die zu dem jeweiligen Lichtemitter parallelgeschaltet ist und in den leitenden Zustand versetzt wird, wenn der Motor abgeschaltet wird.

9. Vorrichtung nach Anspruch 8, bei der die schaltbare Nebenschlußschaltung von der Ansteuerschaltung (20) betätigt wird.

Revendications

1. Appareil pour commander un moteur électrique comprenant:

un premier commutateur électrique unidirectionnel (21, 22, 23) couplant le moteur électrique (12) à une source (A, B, C) d'électricité, et étant activé par un signal électrique pour réguler les moments où ce commutateur est mis en marche,

un second commutateur électrique unidirectionnel (24, 25, 26) relié, dans une relation parallèle inverse, audit premier commutateur électrique unidirectionnel,

un circuit de commande (20) pour activer électriquement le premier commutateur électrique unidirectionnel,

caractérisé en ce que

ledit second commutateur électrique unidirectionnel (24, 25, 26) est activé optiquement,

une alimentation électrique (30) existe pour fournir un courant électrique audit circuit de commande, et

un émetteur de lumière (41, 42, 43) alimenté en énergie par le courant électrique, circule à travers ladite alimentation électrique vers ledit circuit de commande pour produire de la lumière, qui est optiquement couplée pour activer ledit second commutateur électrique unidirectionnel.

2. Appareil selon la revendication 1, caractérisé en ce que ladite alimentation électrique (30) inclut des moyens (31, 32, 33, 34, 35, 36) couplés en série avec ledit émetteur de lumière, pour redresser le courant électrique destiné audit circuit de commande.

3. Appareil selon la revendication 1 ou 2, comprenant en outre des moyens (50, 51, 52) pour empêcher que l'émetteur de lumière n'émette de la lumière lorsque le moteur électrique est arrêté.

4. Appareil selon la revendication 3, caractérisé en ce que les moyens d'empêchement comprennent un élément commutateur (56) fournissant un passage de dérivation pour que le courant évite l'émetteur de lumière lorsque le moteur électrique est arrêté.

5. Appareil selon la revendication 4, caractérisé en ce que ledit élément commutateur (56) est commandé par ledit circuit de commande (20).

6. Appareil pour commander un moteur électrique à courant alternatif triphasé, comprenant:

une première, une seconde et une troisième bornes d'entrée (13, 14, 15) pour relier l'appareil aux trois phases du courant alternatif,

une première, une seconde et une troisième bornes de sortie (16, 17, 18) pour relier l'appareil au moteur électrique (12),

un premier, un second et un troisième commutateurs électriques unidirectionnels (21, 22, 23), dont chacun est activé par un signal électrique qui régule les moments auxquels ledit commutateur est mis en marche, où ledit premier commutateur électrique unidirectionnel (21) couple la première borne d'entrée (13) à la première borne de sortie (16), ledit second commutateur électrique unidirectionnel (22) couple ladite seconde borne d'entrée (14) à ladite seconde borne de sortie (17), et ledit troisième commutateur électrique unidirectionnel (23) couple la troisième borne d'entrée (15) à la troisième borne de sortie (18),

un quatrième, un cinquième et un sixième commutateurs électriques unidirectionnels (24, 25, 26), où ledit quatrième commutateur électrique unidirectionnel (24) est relié dans une relation parallèle inverse, audit premier commutateur électrique unidirectionnel (21), ledit cinquième commutateur électrique unidirectionnel (25) est relié, dans une relation parallèle inverse, audit second commutateur électrique unidirectionnel (22), et ledit sixième commutateur électrique unidirectionnel (26) est relié, dans une relation parallèle inverse, audit troisième commutateur électrique unidirectionnel (23), et

un circuit de commande (20) pour activer électriquement les premier, second et troisième commutateurs électriques unidirectionnels,

caractérisé par

lesdits quatrième, cinquième et sixième commutateurs électriques unidirectionnels (24, 25, 26), chacun activés optiquement,

une alimentation électrique (30) pour fournir un courant électrique audit circuit de commande, incluant trois redresseurs (31, 32, 33) couplant lesdites bornes d'entrée (13, 14, 15) à une première borne d'alimentation électrique (37), et incluant de plus trois ensembles composés d'un émetteur de lumière (41, 42, 43) et d'un redresseur (34, 35, 36), chaque ensemble étant électriquement couplé entre une borne différente parmi lesdites bornes d'alimentation (13, 14, 15) et une seconde borne d'alimentation électrique (38) et chaque émetteur de lumière couplé optiquement de façon à ce que cette lumière provenant de là active un différent des quatrième, cinquième et sixième commutateurs s électriques unidirectionnels (24, 25, 26).

7. Appareil selon la revendication 6, comprenant de plus des moyens (50, 51, 52) pour empêcher les émetteurs de lumière d' émettre de la lumière lorsque le moteur électrique est arrêté.

8. Appareil selon la revendication 7, dans lequel lesdits moyens d'empêchement incluent un circuit de dérivation (56) commutable séparé relié en parallèle à chacun des émetteurs de lumière, et rendu conducteur lorsque le moteur est arrêté.

9. Appareil selon la revendication 8, caractérisé en ce que ledit circuit de dérivation commutable est mis en fonctionnement par ledit circuit de commande (20).

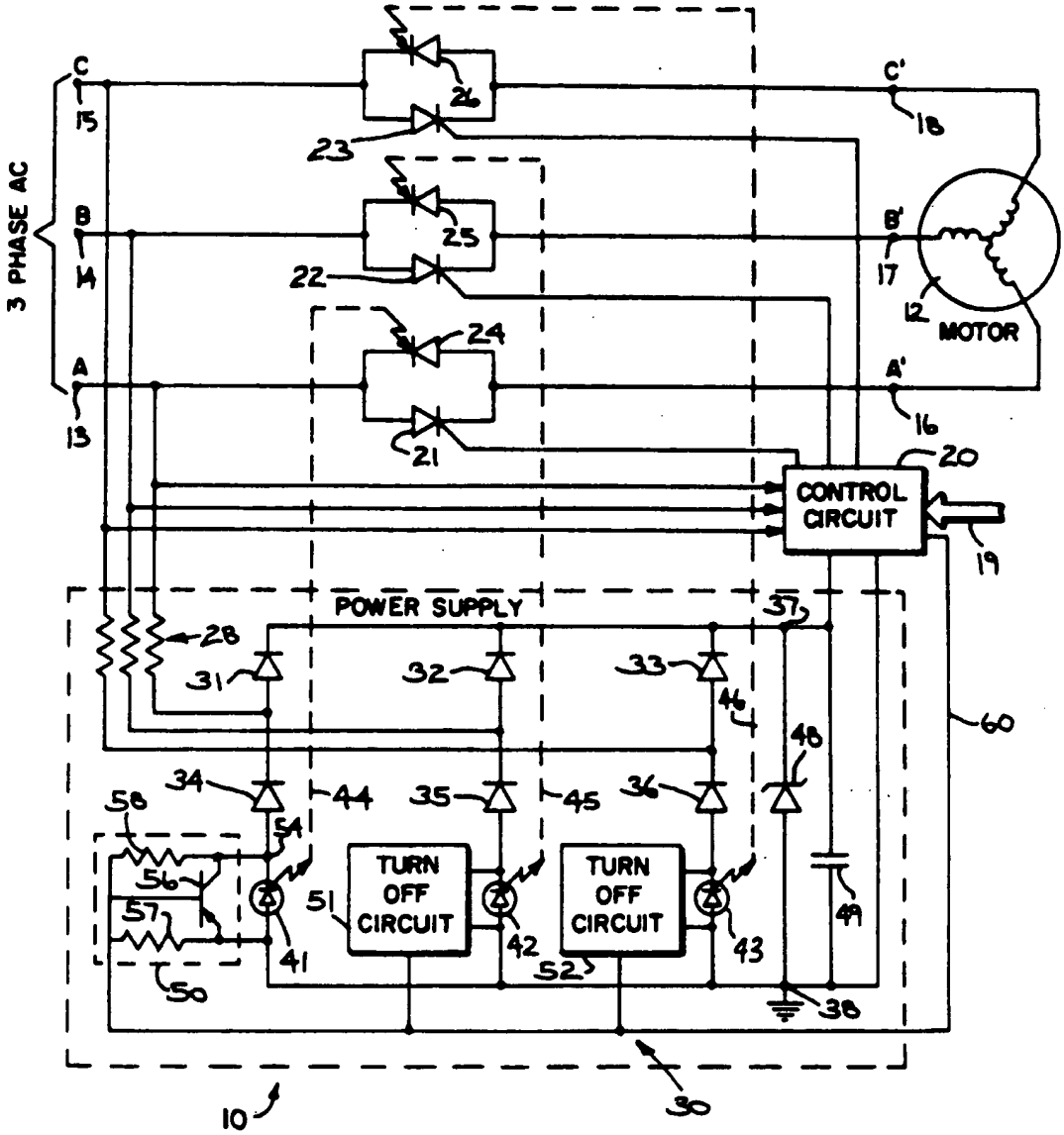
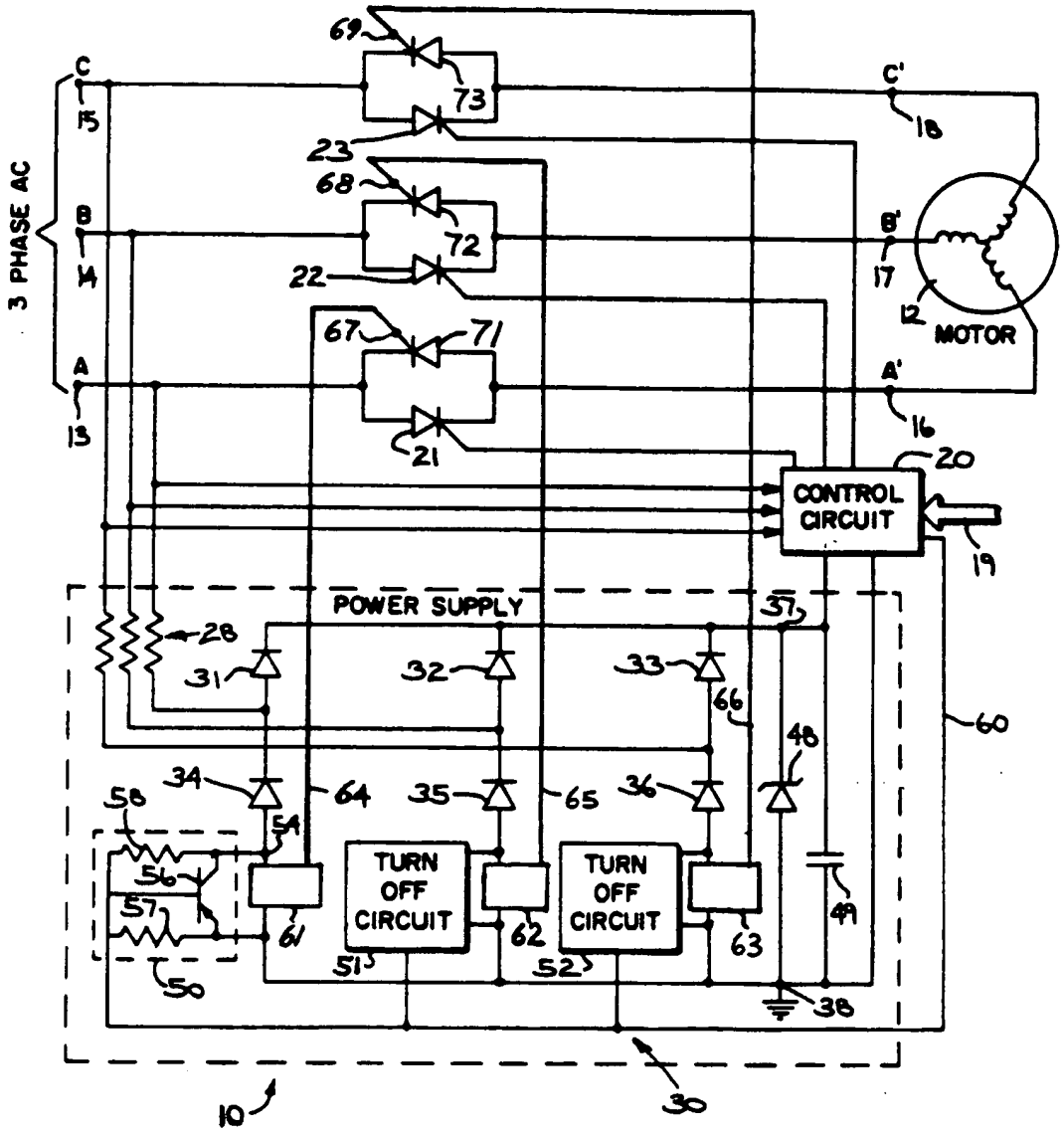

3 PHASE AC
C
15
B
14
A
13
C'
18
B'
17
A'
16
MOTOR
12
CONTROL CIRCUIT
20
19
POWER SUPPLY
TURN OFF CIRCUIT
TURN OFF CIRCUIT
10
30
60

FIG. 1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B'
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MOTOR
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CONTROL CIRCUIT
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57
61
TURN OFF CIRCUIT
62
TURN OFF CIRCUIT
63
49
51
52
50
38
10
30

FIG. 2